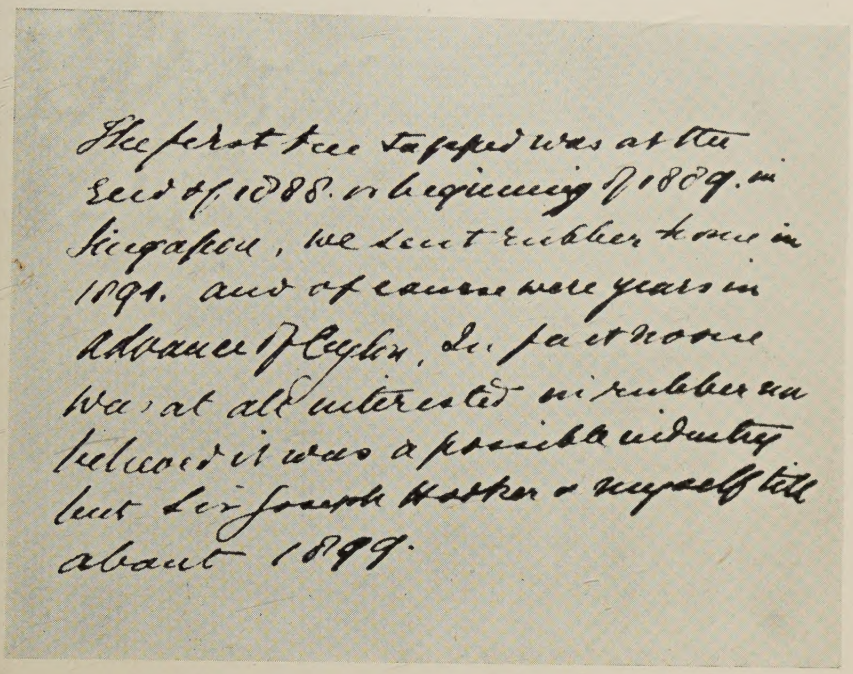
PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA


The first tree tapped was at the
end of 1888. in beginning of 1889. in
Singapore, we sent rubber home in
1891. and of course were years in
advance of Ceylon, &c. for at none
was at all interested in rubber as
believed it was a possible industry
but left fourth Mother & myself till
about 1899.

NEW SERIES NUMBER TWENTYONE

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We regret that our stock of temporary binding cases is exhausted and until the new consignment is received we are unable to accept further orders. Arrival of the new consignment will be announced in a future issue of *Planters' Bulletin.*

PLANTERS' BULLETIN

OF THE RUBBER RESEARCH INSTITUTE OF MALAYA

Kuala Lumpur November 1955 Number 21

Editorial: The True Pioneer

Commercial establishment and development of new crops in all parts of the world owe much to the botanist. The story has been related many times of the part played by Sir Joseph Hooker, then President of the Royal Society and Director of the Royal Botanic Gardens, Kew, in initiating the successful importation of *Hevea brasiliensis* by Mr H. A. Wickham (later Sir Henry) from Brazil and the distribution of plants to Ceylon and India. The subsequent history of *Hevea* in Malaya is equally interesting, and it is particularly fitting to remember it now, because December 10, 1955 is the hundredth birthday of Henry Nicholas Ridley, C.M.G., F.R.S., M.A., F.L.S., Hon. F.I.R.I.

Plants from the Wickham collection were established at Singapore and Kuala Kangsar in1877. The first fruiting was in 1881, and seeds were distributed from both centres. Samples of rubber from Kuala Kangsar were sent to England by the British Resident, Sir Hugh Low, in 1884, but possibly due to some confusion with Ceara scrap rubber, no interest in the Malayan product was stimulated at that time. Moreover, after some crude attempts at 'hatchet' tapping it was thought that *Hevea* yielded poorly. Thus, the founding of Plantations in Malaya was not realised at this first opportunity, the attention of planters being devoted mainly to coffee.

When Ridley took up his appointment as Director of the Gardens, Singapore, in 1888, he found both government and planters totally indifferent to the possibilities of *Hevea.* Ridley immediately took an interest in the 1200 or more trees in the Gardens, which were the progeny of the original collection, but not until about ten years later did any estates consider planting rubber. Then, the price of coffee had fallen and the Malayan coffee plantations were struck by disease. The first estates which turned from coffee to rubber reaped great profits, because progress in motor transport had forced the price of the inadequate supplies of wild rubber to an astronomical figure. New capital was attracted for opening up more estates, many of which, however, were not in production until the 1913 slump.

During the ten years when rubber planting apparently stagnated, Ridley was already studying every aspect of the subject. Samples of rubber were exhibited at the Agri-Horticultural Shows, which he founded, and were sent in 1891 to London, where they were pronounced excellent. Therefore, when rubber planting began in Malaya, interest in the product had already been created and an expert was ready to encourage and advise. But even in this Ridley did not have a free hand. The Colonial Government advanced virtually no funds for this extension and the F.M.S. contributed nothing. The indifference of the

authorities would have discouraged any lesser man. In 1902 the Agricultural Bulletin was first published regularly, but previously Ridley had no means of communicating the results of his hard won agricultural experience to those who needed it. Ridley already was fully occupied in preparing his scientific study of the flora and fauna of Malaya, as well as having thrust upon him by the Government work such as prospecting for minerals, and his perseverance in his agricultural work with no expectation of personal financial reward should make the rubber plantation industry for ever grateful to him.

In addition to his energetic drive in encouraging rubber planting, Ridley's practical contributions were considerable.

The distribution of seed to all places where it was required was by no means easy. The fatty seeds of *Hevea brasiliensis* compared with those of beans or cereals are short lived. Although expanding rapidly communications within Malaya were incomplete at that time. Ridley early discovered the value of packing Hevea seed with just damp charcoal powder in closed tins and this method is still used today. Before 1910 seed had been sent from Singapore and Ceylon to Africa, throughout Asia and to all parts of the Archipelago as far as Australia and even back to America. Over nine million seeds were distributed by Singapore Botanic Gardens alone, and due to the demand warnings were issued of thieves stealing and selling *Hevea* seed.

Incidentally Ridley stated that *Hevea* was insect pollinated, a view which was subsequently doubted but has been recently vindicated.

When plants are grown on a plantation scale some disease must be expected, and Ridley was well aware of the need for its control in order to prevent widespread infection and destruction. He was instrumental in framing and passing into law some of the earliest phytosanitary legislation, (the Singapore ordinance against coconut beetle 1890 and a more general one in 1908). Ridley was the first to record on *Hevea* in Malaya the brown and white root diseases and bird's eye spot leaf disease. The rubber planter of today will be even more struck by the similarity to present day recommendations of Ridley's advice on root disease control, pink disease and dieback treatment. He strongly enjoined the eradication of sources of infection, and used lime and copper sulphate to control pink disease. Bordeaux mixture is still the cheapest effective fungicide for use in immature areas. Ridley described several infections of *Hevea* leaves, but rightly did not consider them serious in Malaya. South American leaf blight has not attacked the Malayan plantations and *Oidium* defoliation is not so severe as in Ceylon.

Ridley did not consider that synthetic rubber would ever be a serious competitor with natural rubber on the grounds of cost, and, being a man who worked hard for the peaceful development of wealth and prosperity, was unable to foresee that, under the impact of a life and death struggle, the greatest industrial nations of the earth would some thirty odd years later achieve the manufacture of synthetic rubber. With synthetic and natural rubber in strong competition, Ridley's work on the economic methods of exploiting *Hevea* can be properly assessed.

In South America most wild trees had been bled by hacking with hatchets, which caused excessive wounding of the trees. Deep grooves cut down to the wood on a herring bone pattern were hardly more successful.

At first alone, and after 1904 in conjunction with Robert Derry, Ridley tried various methods of latex extraction from the tree. Excision tapping methods had been discovered elsewhere in the east, but it was his series of Singapore experiments which established most clearly the principles and manner of tapping used to this day. By his method a thin layer of the lactiferous bark was pared off regularly from a sloping cut, care being taken to avoid cutting deeply and wounding the cambium. Ridley demonstrated that the mere trickle of latex obtained from occasional random incisions could be greatly increased by regularly reopening the same cut. Thus was developed the excision method, by which the cambium is protected; new bark regenerates and may be tapped again thereby extending the useful life of the tree.

Mallet and chisel were the tapping instruments used at first and were soon discarded. Others were tried, of which a modified farrier's knife was found to be best, and is still preferred by many.

Furthermore, Ridley commenced experimenting in the preparation of rubber for shipment and sale. Using improvisations, because he had no budget for this research, he coagulated latex in sheets and devised a smoke house. Mr J. Parkin and Dr J.C. Willis were other workers in this field to whom credit must be given. It was invaluable that Ridley undertook this work because it gave the planter an advisor who was well acquainted with the practical details of processing and who was constantly improving the methods employed.

This is not the place to discuss the multitude of other crops including timber, coconut, fibre, dye, spice and vegetable crops, whose early development in Malaya owes much to Ridley and his assistants. He suggested bananas, chillies and pineapples as catch crops to be planted between the rows of immature rubber, and was justifiably cautious about recommending tapioca for this purpose. He did not favour clean weeding and was interested in trials of cover crops. Probably another of Malaya's great agricultural mainstays is largely due to his initiative, because he was one of the first to suggest oil palm as a plantation crop and distributed over 3,000 seeds. Ridley's comment on a patent to make chewing gum from Jelutong latex bears quoting: 'One would not think it would make a very delectable sweetmeat, but no doubt it will be popular in America'.

The impression might be gathered that the study of the flora was neglected because of the extent to which Ridley applied his activities in the economic expansion of Malayan agriculture, but the five volumes of the Flora of the Malay Peninsula, compiled by Ridley after his retirement from Singapore in 1911, became the first comprehensive review of Malaya's flowering plants and the basis of all subsequent revisions. His observations on birds, insects and animals are of great interest to all Malayan naturalists. In 1930 his classic 'The Dispersal of Plants throughout the World' was published.

Few have made greater contributions to the scientific and economic study of botany, certainly none in Malaya, and these pioneer services were accomplished without any of the facilities or comforts which seem essential for tropical work to be tolerable today. There will be no-one concerned with the rubber industry who will not join in honouring Ridley and wishing him a very happy hundredth birthday.

Superior Processing Crepe

IT IS DIFFICULT TO MANUFACTURE ACCURATELY shaped extruded forms in natural rubber compounds without heavily loading the rubber with fillers, which has the disadvantage of a loss in other desirable properties. In a number of instances plastics and synthetic rubbers have therefore been used instead of natural rubber because of their superior processing behaviour. A new type of rubber has been developed by the Chemical Division of the R.R.I. called Superior Processing Crepe which gives compounds having much better extrusion and calendering characteristics than normal rubbers. It is hoped that S.P. crepe will now enable natural rubber to be used for purposes from which hitherto it was excluded.

Superior processing crepe is a form of natural rubber which contains 20% vulcanised rubber incorporated in a particular way. The method has been patented by the R.R.I. but manufacture may be undertaken under licence from the R.R.I. The method of preparation described herein has been used to prepare over twenty tons at the R.R.I. Experiment Station.

PREPARATION

These details refer to the production of one ton of S.P. crepe per day prepared according to the flowsheet shown in *Figure 1.*

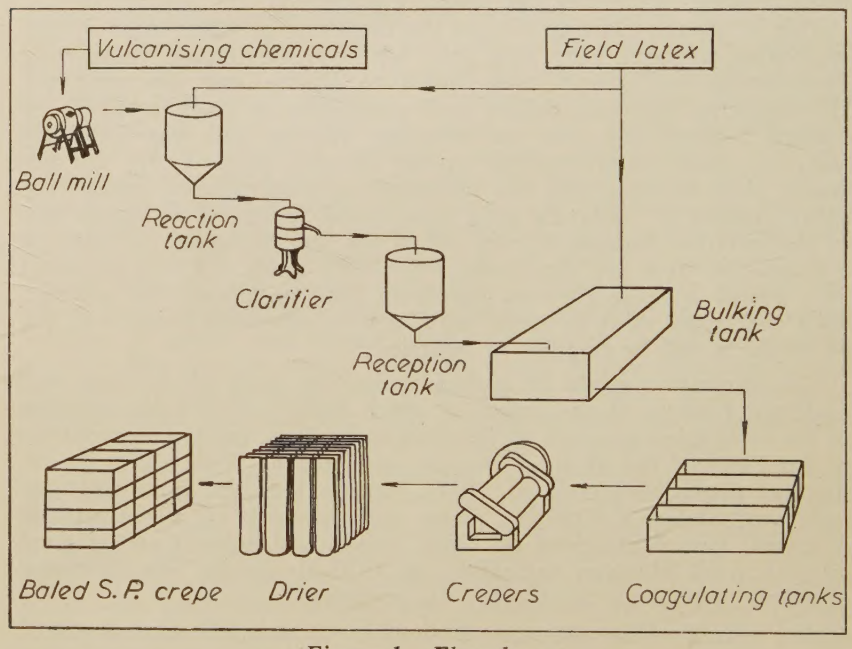


Figure 1. Flowsheet.

The vulcanising suspension is prepared every second day since the ingredients require 36 hours grinding in a ball mill. The chemicals required to prepare one batch of suspension are shown in the following list.

Superior Processing Crepe

Chemicals	*Weight required*
Sulphur	18.0 lb
Zinc oxide	13.5 lb
Sodium diethyldithiocarbamate	1.8 lb
Mercaptobenzthiazole	3.6 lb
Turkey red oil	0.036 lb
Pearl glue	1.8 lb
Phenol	0.036 lb
Water	35.128 lb
Total	73.900 lb

The pearl glue is stirred into about 25 lb of water and heated until it is dissolved. The solution is cooled and filtered through a 60 mesh sieve. The Turkey red oil and phenol are then stirred in and the rest of the water added to give a total weight of 37 lb. The powders are sieved through a 16 mesh sieve and then weighed into the ball mill. The glue solution is also added, after which the mill is closed and run for 36 hours. This procedure gives sufficient suspension for two days use.

Fresh field latex is strained through a 40 mesh sieve into the reaction tank and ammoniated to 0.3%. The d.r.c. is estimated by a rapid method and the amount of vulcanising suspension required is calculated as 8.2% by weight of the rubber to be vulcanised. The latex stirrer is started and the suspension added slowly to the latex. After addition the latex is heated with steam so that it reaches 180°F. in one hour. It is then held at 180°—185°F. for two hours and tested. The test consists of acidifying a small sample with 10% formic acid and noting the condition of the rubber. If the rubber can be rolled between the fingers to give a continuous coagulum vulcanisation is incomplete. A powdery dispersion of rubber shows adequate vulcanisation and heating of the latex is then discontinued.

After the vulcanised latex has cooled it is passed through a centrifugal clarifier to remove excess vulcanising ingredients, sludge *etc.* and then diluted to 20% total solids.

Fresh field latex, without preservative, is diluted to 20% d.r.c. and thoroughly blended with the vulcanised latex in the ratio of four parts fresh latex to one part vulcanised latex. Good mixing is essential.

The mixture is coagulated with 1% formic acid. The quantity of acid required will vary with the amount of ammonia lost during vulcanisation; at the Experiment Station we require 1 oz formic acid to 15 lb rubber. The coagulum is creped and dried in the normal manner.

So far, users of S.P. crepe have desired clean rubber. It is therefore necessary to abandon the normal method of bareback baling and substitute some form of protective wrapping such as paper bags.

EQUIPMENT

An unlined mild steel ball mill has been used for the preparation of the vulcanising suspension. To produce one ton of S.P. crepe per day a ball mill of twentyfive gallons capacity would be required.

The reaction tank may be an open mild steel tank coated with a latex and heat resistant paint. It should be fitted with an efficient slow

speed stirrer, (approximately 50 r.p.m.) an indicating thermometer and a live steam inlet. Automatic steam control is optional. The tank capacity will vary with the field latex d.r.c. but a 200 gallon tank would be suitable if the latex d.r.c. exceeds 30%.

Any good centrifugal clarifier could be used for the process and at our Experiment Station we found that a De Laval L772 machine handled twentyfive gallons of latex per hour and required cleaning every two hours.

The tank provided for receiving latex from the clarifier may also be of mild steel coated with a latex resistant paint. It requires a slow speed stirrer and should be of 300 gallon capacity so that the clarified vulcanised latex may be diluted to 20% total solids.

The bulking tank (1500 gallons) may be the normal type of bulking tank found on most estates and may be constructed from aluminium, painted mild steel, or tiled concrete *etc.* Good mixing is essential in this tank and an efficient slow speed stirrer is most desirable.

Coagulating tanks, creping machinery and drying facilities should handle one ton of rubber per day coagulated at two lb per gallon. They require no further description since they are quite similar to a normal pale crepe installation.

PRODUCTION COSTS

The following table summarises the estimated direct cost of production above the cost of manufacture of pale crepe. It does not include supervision, testing, maintenance, depreciation *etc.* since these charges vary considerably from one factory to another.

TABLE I: COSTS IN STRAITS CENTS PER POUND OF S.P. CREPE

Process	*Chemicals*	*Labour*	*Elect*	*Steam*	*Water*	*Total*
Ammoniation	0.166	0.016	—	—	—	0.182
Suspension preparation	0.562	0.047	0.321	—	—	0.930
Vulcanisation	—	0.109	0.022	0.168	0.002	0.301
Clarification	—	0.141	0.125	—	0.033	0.299
Coagulation	0.039	—	0.014	—	—	0.053
Total	0.767	0.313	0.482	0.168	0.035	1.765

To the above should be added the extra cost of wrapping in special covers such as paper bags. We estimate this to be about 1.7 cents per lb.

TECHNICAL ADVANTAGES

Superior processing rubber, as its name implies, possesses advantages over ordinary crepe and sheet in the intermediate stages of converting raw rubber into the manufactured article. Thus it is more easily brought into the necessary smooth condition for the preliminary shaping of the article. It afterwards retains its shape much better than any other type of rubber, to a degree previously only possible by loading the rubber with large quantities of non-rubber materials. These are important advantages because they enable natural rubber to compete more favourably with synthetic materials.

This superior processing behaviour is particularly advantageous in compounds containing a very high proportion of rubber, where it enables articles to be manufactured, such as thin walled tubing and high grade rubber covered wire which previously had to be made from plastics in order to obtain a smooth surface and accurate dimensions.

To fully appreciate the advantage to the consumer of superior processing rubber it is necessary to know something of the operations used in rubber manufacture. These comprise the plastication of the rubber, addition of vulcanising and compounding ingredients to the plastic mass, shaping to the final contours desired in the finished article, and vulcanisation. The advantages of superior processing rubber are apparent at each stage of these operations and are illustrated in the accompanying photographs*.

The first step, known as mastication, is carried out at temperatures well above ambient, either in an internal mixer or on a pair of horizontal rolls moving at unequal speeds. This breaks the rubber down to a putty-like mass which, however, is still somewhat elastic.

Superior processing rubber more quickly forms a smooth band on a heated two-roll mill, and on removal retains a much greater proportion of its original length than ordinary sheet or crepe (*Figure 2*).

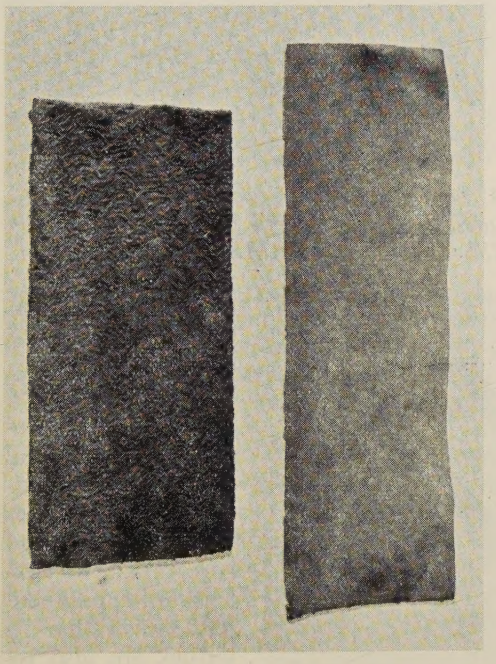


Figure 2. Mill shrinkage test (left) ribbed smoked sheet and (right) superior processing rubber.

The next operation, that of compounding, is likewise carried out in an internal mixer or on an open two-roll mill, followed in either case by sheeting off on another open mill with rolls moving at equal speeds. The compound may then either be moulded and vulcanised in a press, as in mechanical goods such as soles, heels, bathing caps and numerous other articles, or be extruded through a heated die of suitable cross section. This may be an intermediate stage in manufacture as in tyre treads, or the extrusion may correspond to the final shape of the finished article as for example, car and cycle inner tubes, gas tubing, windscreen and other strips of a wide variety of sections.

* *Reproduced by the courtesy of the Institution of the Rubber Industry and taken from a technical paper by H.C. Baker submitted for publication in Transactions of the I.R.I.*

Ideally the extruded article would retain accurately the dimensions of the die, but in practice considerable longitudinal shrinkage and lateral swelling occurs. Similarly a calendered sheet would ideally retain the exact thickness imposed on it by the setting of the calender rolls, but in practice it is necessary to allow for the swelling of the rubber as it leaves the calender nip.

Of equal importance to retention of shape is smoothness of the compound as it leaves the rolls or the extruder. The production of extrusions and calendered sheets having a smooth surface from a natural rubber compound containing vulcanising ingredients only is extremely difficult. In addition, where an extrusion is vulcanised in hot air or open steam, shape distortion frequently occurs due to sagging of the product under its own weight. Extrusions of 'pure gum' stocks can now be made using S.P. crepe *(Figure 3)*.

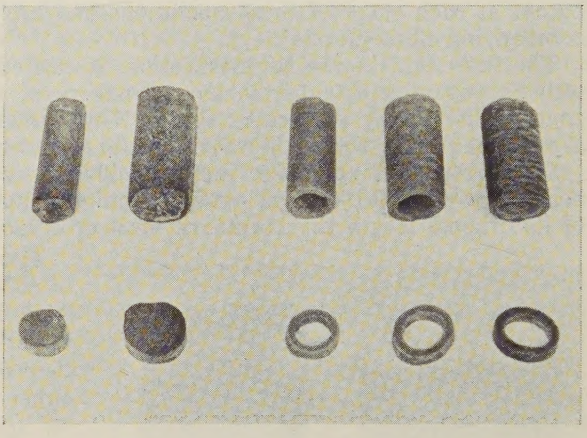


Figure 3. Samples of lightly loaded cord and tubing extruded through the same die. Left to right S.P. crepe, RSS 1, S.P. crepe, RMA crepe and RSS 1.

The rate of extrusion can be considerably increased when S.P. crepe is used because the same finished diameter is obtained from a larger aperture die *(Figure 4)*.

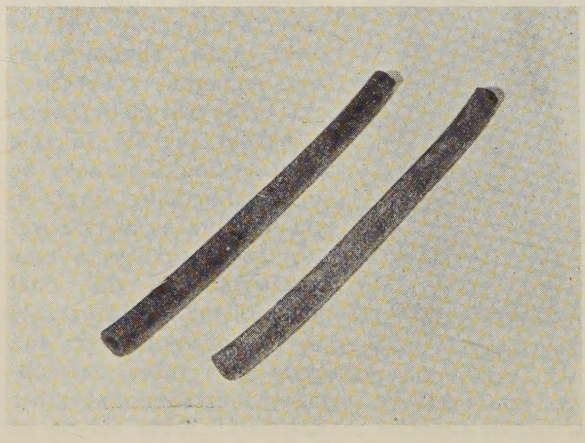


Figure 4. The lightly loaded tubing from S.P. crepe (left) was extruded through a die twice the size of that used for similar tubing of the same finished diameter from RSS 1 (right).

Although at present the principal opening for superior processing rubber is in lightly loaded compounds for extrusion, experiment has shown that its virtues are also retained in more highly loaded compounds. Not only do the products show greater smoothness and better

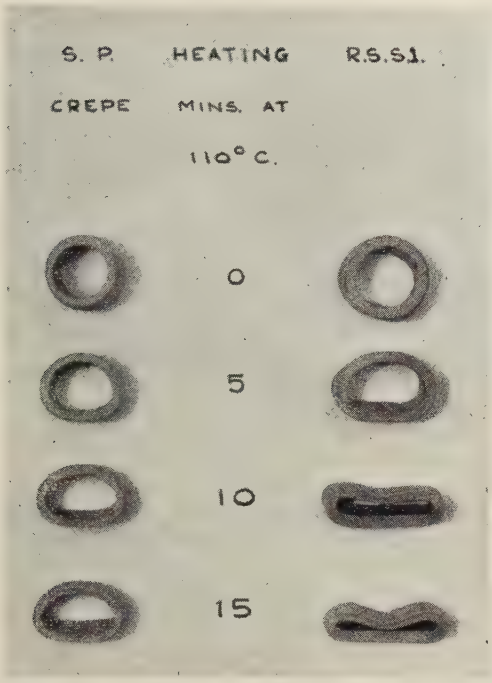


Figure 5. Section of unvulcanised white loaded tubing (60 volumes whiting) after heat collapse tests in an air oven at 110°C.

shape but also greater resistance to deformation under heat which is very important to ensure that the article retains its shape during vulcanisation *(Figure 5).*

Finally, vulcanisation is accompanied by a slight shrinkage in dimensions of the finished article on cooling. There is evidence that this shrinkage is less for superior processing rubber than for ordinary crepe and sheet.

MARKET DEMAND

The market demand for S.P. crepe is difficult to predict. However, the details given above in 'Technical Advantages' show that the rubber consuming industries could use appreciable quantities of S.P. crepe. The small scale production (two tons per month) at our Experiment Station has been marketed in the U.K. at a premium of two pence per lb over pale crepe. Since demand exceeds supply we now feel confident in drawing the attention of producers to the possibilities of commercial production of S.P. crepe in Malaya.

R. R. I. News

A number of copies of a new booklet *Replanting on Smallholdings,* prepared for our Smallholders' Advisory Service, have been reserved for readers of *Planters' Bulletin.* The cost is $1 post free in Malaya. This illustrated manual, of 54 pages, comprises sections on the site, planting and maintenance, and should be of particular interest to the managers of smaller estates and to young assistants.

The yellow tea mite (*Hemitarsonemus latus*), of which a description appeared in *Planters' Bulletin 9* on page 126, can be effectively controlled by spraying with dieldrin (0.05 per cent active ingredient) or endrin (0.025 per cent active ingredient). A second application should be given five days later. Both these insecticides can be used more freely than materials previously recommended as they are harmless to the predacious mite (*Typhlodromus newsami*) which itself acts as a control.

Smoke Houses

OUR ADVISORY WORK HAS SHOWN THAT FACTORS involved in the planning, construction and operation of smoke houses are often neglected, so that inefficient smoking of sheet rubber ensues. The following notes are prepared to draw attention to these common problems. Complete details of the R.R.I. and Subur types of smoke house are given in publications referred to at the end of this article. Although these were issued years ago the two types of smoke house described are still considered quite satisfactory and no major improvement can be recommended.

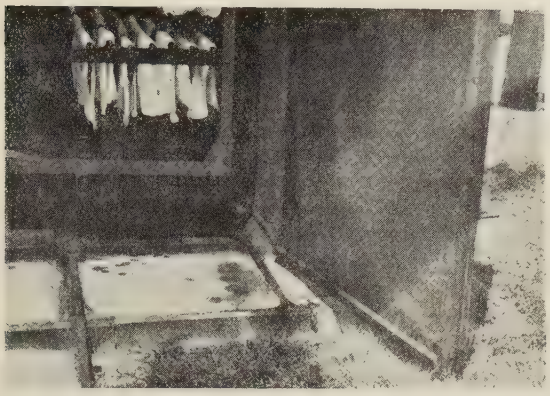
Planning — The old types of multistorey smoke house are gradually being replaced by the more efficient R.R.I. and Subur types. The main advantages of these are that they require less labour for operation, they have a shorter drying cycle, their temperatures are more easily controlled, and they usually give a higher percentage of first quality sheets. We favour the R.R.I. type smoke houses for most estates but emphasise that they are quite unsuitable for an area with a high water table, since their furnaces and flues are below ground level. A damp site requires a modified Subur type smoke house with furnaces and flues above ground level. Many of these have been installed and are working efficiently. If seepage into the furnace and flues of an R.R.I. type smoke house does occur a drain should be installed completely round the smoke house with an outlet to an open drain of lower level.

Both Subur and R.R.I. smoke houses are usually designed to handle 1000, 2000, or 4000 lb rubber per day on a four day drying cycle, although successful modifications to these sizes have been made. After the type and size of smoke house have been chosen, it should then be located at least 20 ft from other smoke houses and at least 50 ft from any other building. Failure to observe these limits could lead to a considerable increase in insurance premiums on neighbouring buildings.

Construction — Brick smoke houses have become more popular in recent years because managers have found that they cost little more to construct, require less maintenance, last longer and look better than a wooden framed unit.

The two most common faults made in the construction of new smoke houses are failure to seal the space between ceiling and roof, and failure to provide good drainage on the floor at the cool end of the smoke house. The former fault allows moisture to condense on the ceiling from the humid smoke house atmosphere. This moisture then absorbs dark coloured substances from the smoke and drops

Moisture dripping from skim sheet after ¾ hour in the smoke house. The floor is wet and water runs down the drain beside the wall.



Drippings from ribbed smoked sheet run readily away to an outside drain.

from the ceiling on to the sheet to cause dark sticky stains. The trouble can usually be eliminated by sealing the space between the ceiling and the roof near the eaves. The other fault is difficult to rectify in a finished smoke house, so care should be taken during construction to see that drainage is sufficient. When wet sheets warm up after being placed in the smoke house, several gallons of water from the rubber on each truck are eliminated within a few hours by 'sweating' and dripping. Drains should convey the water outside the smoke house as quickly as possible.

Operation — Efficient smoking depends mainly on correct smoke house temperatures. Experience has shown that the temperatures during the four day drying cycle should be 120° to 125°F on the first day, 125° to 135°F on the second, 135° to 140°F on the third and 140° to 145°F on the last day. These temperatures can usually be obtained in the R.R.I. type smoke house by setting the smoke outlets (in the floor) fully open at the cool end and one eighth open at the hot end, with intermediate settings for the outlets between. Similarly, the settings for the roof ventilators are three quarters open at the cool end and fully closed at the hot end, with intermediate settings for the ventilators between. These settings are given as a starting point when trying to obtain the correct temperature — they may require small adjustments after trial. A recording thermometer allows a close check on temperature fluctuations in the smoke house, but indicating or maximum and minimum thermometers are sometimes sufficient. If a smoke house is not operated efficiently the following faults may be found.

FAULT IN SHEET	CAUSE	CURE
Rust	Temperature too low for first day.	Raise cool end temperature.
Bubbles	Temperature too high for first day.	Lower cool end temperature to 120°-125°F.
Blisters	Final temperature too high.	Do not allow smoke house temperature to exceed 145°F.
Not dry in 4 days	Temperature too low.	Keep temperature continually between 120° & 145°F.

Some of these faults may have other causes (See R.R.I. *Information Cards*, 4 & 5). This advice is the result of much practical experience but we are now studying the fundamental aspects of rubber drying. The study may make little difference to our recommendations for smoke house operation but it should lead to the design of an efficient drying cycle for air dried sheet, which is becoming increasingly popular.

Our manual 'R.R.I.-Type Smoke-houses' (price $2) gives details of the construction and operation of a recommended design of tunnel smoke house, based on a long series of experiments. Plans and bills of quantities are included.

A reprint is available (free on request) of the paper on '"Subur" type Smoke-houses,' by A. Moore and J.H. Piddlesden, which appeared in the Journal of the Rubber Research Institute of Malaya, Volume 7, page 147.

Cover Seed Testing

Sound appraisal of cover crop seed depends mainly on the manner of sampling, therefore samples need to be taken carefully and uniformly if test results are to be of value.

After inspection for purity, samples sent to us undergo three germination tests. The conditions of these tests approximate to alternative estate practices — no treatment; treatment with hot water; treatment with sulphuric acid. We usually report within a month.

When the germination percentages for treated and untreated seed differ widely, this indicates a high proportion of hard seed. Such seed need pretreatment (as described in *Planters' Bulletin 14*, page 88) if they are to germinate rapidly in the field; otherwise they lie dormant and perhaps germinate eventually when a dense growth of weeds covers the soil. This knowledge justifies the extra time taken in making the three tests.

The sample should be as representative as possible. No attempt should be made to select good seed, or to clean away dirt and chaff. The responsibility rests with the supplier, to avoid bias. The minimum weight which we require is shown below:

Calopogonium mucunoides	2 oz
Centrosema plumerii	6 oz
Centrosema pubescens	3 oz
Crotalaria anagyroides	3 oz
Desmodium ovalifolium	1 oz
Mimosa invisa	1 oz
Pueraria javanica	2 oz
Tephrosia candida	3 oz

One such sample is needed from each bag, or hundredweight of seed. Each bag and its corresponding sample should be clearly labelled with a number. Small quantities of seed should be taken from as many different parts of the bag or bin as possible—from top, middle, bottom, sides. This may be done conveniently when the seed is tipped out for drying, or for making into smaller lots. Seed thus collected should be thoroughly mixed and spread on a flat surface, and portions should be scooped from different places until enough is obtained for the sample.

Slugs and Snails

THE GROUP OF SOFT BODIED ANIMALS called Mollusca is mainly aquatic and includes the snails, limpets, oysters and cuttlefish. Here we are concerned with the land snails and their close relatives the slugs, which differ from snails in having no shell or only a small one which may be hidden in a fold of skin. Several are pests of cultivated plants in Malaya. They feed mostly on leaves and buds, rasping the plant tissues away by means of a horny tongue. Sometimes they damage young rubber and leguminous covers, while in mature rubber they occasionally eat the inner bark exposed by tapping, or drink the latex as it oozes from the tapping cut. Sugars contained in the latex are probably the attraction, but latex drinking is rare and of no consequence.

Slugs and snails feed at night; they become active towards dusk and hide by day in the shade of the undergrowth. They avoid dry conditions and are seen in greatest numbers during wet seasons. The slimy fluid which they secrete from a gland in the foot assists them in gliding along and, spreading over the body, affords protection against irritant substances that may fall on them.

The most conspicuous of these pests is the giant snail (*Achatina fulica*) with its familiar large chestnut brown shell marked with light brown or yellowish lines. A fully grown specimen may have a shell between four and five inches long; even seven inches is recorded. Primarily a pest of vegetable gardens, it has been recorded as eating the shoots of germinating rubber seed. In addition to vegetation it will eat decaying plant and animal matter. During the last hundred and fifty years it has spread eastwards from its original home in Africa to many tropical and subtropical countries – Mauritius, Seychelles, India, Ceylon, Malaya, thence to Siam, IndoChina, Hongkong, Formosa, Borneo, Indonesia, Japan and Hawaii. It even reached California but did not become established. Authorities believe that it first invaded Malaya in Kedah, some time in 1911. Chinese farmers who fed the giant snail to their ducks were perhaps responsible for its rapid spread within the country and beyond.

Snails and slugs are hermaphrodites. The giant snail, of which the life history is known, reaches maturity at the end of a year, though two years are required to attain full growth. Yellowish eggs about the size of a pea are laid at the rate of 100 to 300 per season in clusters in the soil. This high fecundity is counterbalanced by predators. Birds, carnivorous snails and the larva of a glowworm are the giant snail's chief enemies. Jungle pigs go for it, too, and several predatory beetles attack it in its original home in Africa.

Two other snails (*Subulina octona* and a species of *Amphidromus*) are mentioned in passing. The former, a small snail with a narrow tapering shell, has been found in large numbers feeding on *Centrosema pubescens*. The latter is a medium sized snail; its shell is compared with *Subulina* and *Achatina* in *Figure 1*. Species of the genus *Amphidromus* are unusual in that both left and right hand spiral shells are found.

Only two species of slugs are capable of seriously damaging rubber, namely *Mariaella dussumieri* and *Parmarion martensi*. On several estates they have caused extensive damage in young replantings where the ground cover provided them with good shelter by day; at night

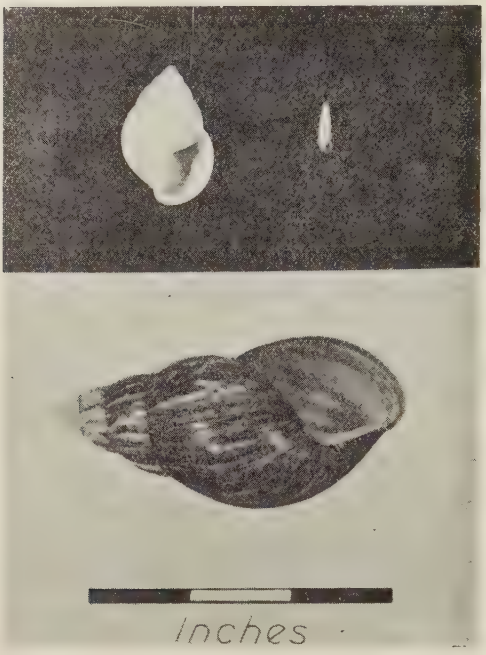


Figure 1. Shells of a species of Amphidromus, Subulina octona (above) and the giant snail — Achatina fulica.

they climbed the stems to eat the buds. Slug damage is so characteristic that it may be recognised easily even though the slugs themselves escape attention by remaining hidden. When the growing point of the stem is destroyed, side shoots develop which in turn suffer a similar fate. After some time the result is a compact cluster of shoots, variously branched and aborted at different stages of development (*Figure 2*). Meanwhile the plant becomes seriously stunted and may even die.

Mariaella dussumieri is yellowish brown with dark lines and spots on the dorsal side. It attains a length of two to three inches. A small shell is hidden beneath a fold of skin which has a longitudinal ridge on each side. *Parmarion martensi* somewhat resembles *M. dussumieri* but is slightly smaller and its shieldlike shell is on the outside, covering the greater part of the visceral mass (*Figure 3*).

Control – Hand collecting was for many years the most practicable method of controlling slugs and snails. Clean weeding, although a bad agricultural practice, helped to keep down their numbers. Lime is attractive to snails, being required in building the shell, and briquettes containing

Figure 2. Slug damage to the growing point of the stem.

lime and a poison had some success against them. In 1936 the discovery was made that slugs and snails were most efficiently destroyed by metaldehyde, best known as the dry fuel 'meta'. Since then its use has spread to Malaya and other parts of the world. Direct application to plants is not recommended; it is better to attract the pests to poison baits. Rice bran makes a cheap and effective bait base. The procedure is to mix powdered meta with rice bran at the rate of half an ounce to one pound. The ingredients are mixed dry, then moistened until the particles just stick together. The bait is distributed in small heaps or made into balls, one near each affected plant, or distributed at intervals of about twenty feet in an unplanted area. Three to five pounds of bait per acre should be sufficient.

Figure 3. The slug Parmarion martensi and Mariaella dussumieri.

If left unprotected from the weather this bait is quickly lost. To enclose it in lengths of bamboo or cover it with tins is too laborious for large scale use. We therefore developed a formula for making meta-bran bricks which are durable even when exposed to rain and sun. They are never as attractive as fresh baits, but their continued effectiveness over many weeks if not months is a great advantage. The formula, selected after testing many mixes, contains in parts by weight:- meta 1, lime 6, cement 6, and rice bran 2. The finely powdered meta, lime and cement are mixed dry with the bran, then about one third of its volume of water is added with much kneading to get the mixture evenly wetted until it has the consistency of building mortar, when it is cast into small bricks in a suitable mould. To become really firm they must be allowed to dry slowly for about a week before being distributed over the affected area. The materials to make a hundred (2 in × 1 in × 1 in) cost less than two dollars (Malayan).

When heavy infestations are encountered it is a good practice first to reduce the snail or slug population quickly by putting down the ordinary bran mash bait. Meanwhile the bricks can be made ready for distribution and placed where they are seen to be needed, to keep the area substantially free from attack.

Potassium Deficiency — Severe potassium deficiency symptoms have been observed in rubber grown in Malacca and the same deficiency is suspected on a Johore estate. The deficiency may occur more frequently than hitherto suspected. This information modifies the statement in last December's issue of our *Journal* (Volume 14, page 254) that 'The incidence of potassium deficiency symptoms in Malaya has not yet been demonstrated'. Symptoms were only recently described — in the issue cited; this may account for the lack of previous recorded instances.

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R.R.I. Lectures to Planters

During 1956 it will be possible for the following lectures to be given by senior officers of the institute. The demand for such lectures has been considerable and we cannot undertake to meet all requests. Early application, for not more than two fixtures is therefore recommended and alternative choices should be given.

SOILS DIVISION

G.M.F. GRUNDY: *Soil factors affecting growth of rubber roots*

BOTANICAL DIVISION

E.D.C. BAPTIST: *Problems of current interest to Planters*
C.W. BROOKSON: *Improvement of Hevea*
P.DE JONGE: *Yield stimulation*
P.R. WYCHERLEY: *Hevea planting material*

PATHOLOGICAL DIVISION

F.W. HUTCHISON (before April): *Root diseases*
R.N. HILTON (before August): *Pink disease*
South American leaf blight

CHEMICAL DIVISION

J.B. MORRIS (before June): *Anticoagulants*
G.W. DRAKE (after June): *Anticoagulants*
D.J. GRAHAM: *Importance of cleanliness in latex concentrate production*
H.M. EDMONDSON: *Modified rubbers*

Inquiry should be made of the Director.

OUR COVER SHOWS AN EXTRACT FROM AN ORIGINAL LETTER WRITTEN BY H.N. RIDLEY DATED 10 SEPTEMBER 1934.

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